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Low carbon energy and international development: from research impact to policymaking

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ABSTRACT

Few areas of international development research have seen as much transformation over recent years as those relating to energy access and low carbon transitions. New policy initiatives, technological innovations and business models have radically transformed the configuration and dynamics of the sector, driven by the urgency of ongoing climate change. This article asks how, given these rapidly moving contexts, policymakers can engage with research at different scales to gather evidence needed for effective decision-making, particularly within the context of the frequently opposing aims of increasing energy access and climate change mitigation. The authors trace the general debates around how research impact is conceived within different constituencies, before exploring the relationship between policymakers, the academic community and other stakeholders within the specific context of energy and international development research. Drawing on cross-cutting lessons from thirteen research projects funded by UK research councils and government under the Understanding Sustainable Energy Solutions programme, they examine critically ways in which impact and engagement have been conceived by both researchers and research funders. They ask how those lessons can feed into the design of future initiatives to make low carbon transitions meaningful as pathways for inclusive development in communities in Africa and Asia.

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Introduction

Climate-change-driven low carbon energy transitions have become an increasingly prominent component in visions for sustainable development over the past decade (Brown, Cloke, Gent, Johnson, & Hill, 2014; Ockwell & Byrne, 2016). The insistent emergence of climate change in fields of governance (frequently in the face of fierce resistance) is gradually forcing the development of new ways of 'doing policy' as policymakers grapple with meeting carbon emissions targets at the same time as global temperature rises are heralding new and forbidding climatological phenomena. Some of the challenges of increasing energy access within the context of low carbon energy transitions are captured in outline

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form in the 'Energy trilemma' conceptualised by the World Energy Council (2013). Developing a policy that addresses the three core trilemma dimensions of energy security, energy equity and reducing energy's GHG emissions demands recognition of the complex interwoven links between public and private actors, governments and regulators, economic and social factors, natural resources and the pressing urgency of global warming. Although not without its limitations, the trilemma concept has the potential to provide a multi-faceted integrating framework for discussing UK government and international energy sector futures, in a way that complements the wider climate change debate while emphasising the role of policymakers.

Access to modern energy services has long been considered as a key contributor to sustainable development, although we should be cautious about drawing too simplistic parallels between energy access and livelihood improvement (Cook, 2011). The complexity and multiple dimensions of energy equity create difficulties in disentangling energy poverty from the two other elements of the trilemma: climate change and energy security (Tomei & Gent, 2015). Despite this complexity, an emerging consensus on the need to tackle global energy poverty in an unprecedented way has catalysed a step change in energy access activity since the launch of the UN Sustainable Energy for All initiative in 2012 and subsequent agreement on the Sustainable Development Goals (SDGs), including the SDG 7 to ensure access to affordable, reliable, sustainable and modern energy for all by 2030. This consensus has resulted in a unifying sector framework for countries and development partners alike, for tracking progress against the ambitious international goals for energy access and, most important for our purposes, evaluating the impacts of research designed to support these initiatives.

Nevertheless, innovative but untested visions of energy futures at the national and international scale must also be underpinned by sound reasoning and critical assessment of the evidence on the role low carbon energy innovation can play in livelihood options at the local scale, particularly in places and social contexts of apparent development need. Communities of the poor, who thus far have not been well served by fossil fuel-driven models of development, need to be able to appropriate, assume and apply low carbon solutions for problems in their home contexts. The literature on technology and development (Bray, 2007; Dove & Kammen, 2015; Feldman & Briggs, 2012; Leach, Scoones, & Wynne, 2005) is, however, full of examples where techno-social visions deploying inappropriate equipment, inputs and infrastructures have followed naïve paradigms of innovation. Social scientists have analysed ways in which interventions (by energy companies, NGOs or governments) and policies have missed research messages about the need to understand diverse contexts of users, resulting in top-down engineered solutions failing to connect with local needs, preferences and aspirations, not to mention gender norms working against women's energy interests, practical dispositions and aspirations.

Socio-technically aware research and project implementation methodologies have the great potential to reduce such failures. In terms of participatory low carbon transitions, knowing where to look for impact and understanding the formal/informal institutions of everyday coping mechanisms of fuel and energy service flows would greatly enrich the field of low carbon energy innovation in the Global South; the granular qualities of peoples' needs, preferences and means for taking action would be made much more visible (Bazilian & Pielke, 2013; Ockwell & Byrne, 2016; Rolffs, Ockwell, & Byrne, 2015; Winther, 2015). As a set of guidelines, Agenda 21 of the Rio Earth Summit formalised a

paradigm change for sustainable natural resource management systems in the development industry's adoption of sustainability. One message was that natural resources can often best be managed by self-organising local systems of surveillance and cautious harvesting, which applies equally to low carbon energy.

How, though, can such impact-focused research initiatives be best promoted? Effective sustainable energy impact is located in an ecology of intra-academic practices that both research funders and researchers themselves recognise must prioritise the interface with non-academics, the use of policy discourse, local knowledge and critical poverty analysis, to make a difference and share the learning process. Here, we explore the approach of the UK Department for International Development (DfID) in initiating impact-focused research in this field via support for a programme of collaborative work undertaken through the Low Carbon Energy for Development Network (LCEDN) since 2013, designed to network and strengthen the UK-funded research being undertaken in support of pro-poor renewable energy interventions. The article proceeds by exploring some elements of the current wider debates over the meaning and measurement of research impact, before going on to explore both the evolution of an integrated programme of UK-funded sustainable energy-focused projects specifically aimed at fostering that ecology, and how the ongoing learning process from those experiences is being used to feed the direction of further research interventions.

Transdisciplinary research and impact

Since 2000, a significant shift has occurred within the evaluation of the quality of academic research to ensure such assessments encompass the impact of that research on policy outcomes. In the UK, for example, a considerable debate (Reale et al., 2017; Strathern, 2000) has arisen about the measurement of impact, and tensions certainly exist between the understandings of impact held by research councils, academics and other stakeholders such as government departments, businesses and civil society organisations. One central element of this debate is the distinction between linear and networked models of how impact might be achieved. The more linear models of how academic research produces an impact, which have influenced how research is measured through the UK's research excellence framework (REF) and other similar exercises, are coming under increasing critical analysis (Nicholls, 2015; Shortt, Pearce, Mitchell, & Smith, 2016). Here we take the stance that it is a networked, rather than linear, model of the impact that needs to be embraced and deployed. A networked approach to the impacts of research in low carbon energy transitions conceives impact to be dialogically produced as an outcome of exchanges of viewpoints, thereby recognising a diversity of positions and perspectives that result in more than the sum of aggregate parts and achieving a means of moving beyond interdisciplinary lines. The impact is an effect of interaction, networking by mutual learning and ways of seeing transitions from different angles. In this respect, innovative methodologies such as the participatory conception of impact pathways take cognisance of mutual understanding and interactions that facilitate innovation (Alvarez et al., 2010). Co-production of socio-technical innovation means livelihood adaptations are taken up for distinctive purposes and conditions, and in relationships of differential power. Here, the field of operation for creating a dialogue about impact is what matters.

By contrast, the competitive model to which the UK higher education (HE) sector is subjected works in the opposite direction: from Personal Development Reviews for individual academics and researchers, through research groups, centres, departments and schools, collaborative effort is sidelined in favour of individualistic 'silo-ised' metrics that are easier to measure, and which can be used to promote the overall performance of the university in the pursuit of funding. Although UK HE institutions frequently discuss transdisciplinary approaches as vital to research and teaching, current HE financial models and the drive for inter-institutional competition effectively discourages such initiatives, even though recent reports on the HE sector continue to stress the importance (and lack of) such initiatives (British Academy, 2016).

We, therefore, 'need to talk about impact' (Smith & Stewart, 2017, p. 109) within the low carbon energy for development community in a way that makes sense not only across the variety of actors involved, who come from extremely different backgrounds in terms of their disciplinary readiness to engage with policy, but also in how such metrics for impact requiring transdisciplinarity can be harmonised with institutional pressures that stand to frustrate them. This approach means thinking about pluralising understandings of impact rather than engineering them in advance to predefined ends. Robbins, Wield, and Wilson (2017) discuss their mapping of research impact in development projects, and initial expectations in their thinking that pro-poor humanitarian and small-scale 'frugal innovations' would have been prominent in the UK REF impact case studies that they scrutinised. Instead, they found a prevailing discourse of ecological modernisation in which economic outcomes and large scales were most valued. The authors highlight that this was a choice made by the case study authors about the kind of storylines of impact they considered would be favourably received by those charged with 'judging' impact. Academics with more humanitarian inclinations and less techno-centric impact narratives are not intrinsically opposed to the more linear definitions currently shaping research impact submissions, but Robbins et al. (2017) found little discussion on the differences between 'academic' impact and meeting development policy objectives.

Evolving approaches to development and technology innovation

Current perspectives on the uptake of renewable energy technologies across the Global South can sometimes seem extremely linear and deterministic in their assumptions about research impacts. The goal of much research, it would appear, is to design technologies that can deliver electricity at scale and at relatively low cost, without increasing global carbon emissions. The focus is generally on the more easily measurable goal of electricity access, despite the massive need for improvement in other key elements of energy provision such as heat for cooking or fuels for transport and motive power. Impact in this context equals the number of sales of equipment or the numbers of connections made to networks, rather than the implications of that access upon livelihood opportunities, the quality of life and pre-existing inequalities and social divisions.

This emphasis has tended to feed the dominance of perspectives that prioritise oversimplistic promotion of North–South technology transfer and technological determinism in the evolution of policy. Other areas of research, however, have had a stronger emphasis on the valuing of local knowledge practices, thereby inspiring an immensely rich literature on local and indigenous capacities for learning and adapting to a wide range of different

techno-economic transformations (Leach et al., 2005; Richards, 1985). This literature advocates symmetry between the knowledge of 'scientific' experts from Northern countries and the homegrown empirical knowledge of local people. Critical development studies interrogate how the 'social slot' gets left to pick up the user interface at the 'end of the pipe', in contrast to commonplace notions of interdisciplinarity, in which knowledge is imagined to be capable of selectively recombining knowledge from different component domains of natural and social science (Wellberry, 2009).

In contrast to piecing different parts of the jigsaw together with compatible data sets, the different framings of problems and perspectives offered by considering all actors in a social field as plausible innovation stakeholders has opened up development policy and intervention paradigms, revealing the differential benefits to broad categories of people and options available for innovation, for instance by foregrounding questions about gender and energy (Winter, Matinga, Ulsrud, & Standal, 2017). These types of impact do not lend themselves to additive logics or to linear measures of progress or impact, but to more normative evaluations of fluid ways of life and their potential for change (Bulkeley & Castan Broto, 2013; Castree et al., 2014).

Renewable energy project beneficiaries are not just receivers of technology; they are reflective observers of a complex, and challenging world, who prioritise time and resources in constrained circumstances. Individual or communal decisions about whether to adopt a new solar home system, wind turbine or biogas unit will be influenced, among others, by observation of the technology's effectiveness for other people they know. Low carbon development in off-grid distributed contexts of use needs to pay particular attention to organic kinds of technology governance practice, and to understand the relationships that affect uptake, capacity development and impact (Byrne et al., 2012).

In addition, the impact of research depends not only on how research findings are communicated but also on the receptivity of different actors to hearing a given message, interpreting a case study or to finding a piece of analysis convincing. Actor networks are key, and not simply the human protagonists: equipment and installations of infrastructure have different kinds of impact for different sets of users. Low carbon energy technologies should be seen as assemblages with possibilities for applications not foreseen by their designers (de Laet & Mol, 2000). They carry capacities for modification in an arrangement, by which actors may find them more or differently useful; and their impacts depend on how different actors can align them with domestic, productive and aesthetic purposes. As a direct result, the impact can be tracked in changes made to people's ability to see value in realistic enhancements to their lives, not in unreasonable transformations of technical possibility. Moving beyond collaborative forms of interdisciplinarity, problem-setting and innovatory capacities of beneficiary communities and other stakeholders makes a vital contribution and steers the technological input to development projects through degrees of ownership. Local applications and productive utility of materials and purposes align themselves into formulations that can be borrowed and tested in other locations. Bespoke solutions for context-specific needs make excellent case studies for thinking about scaling up, as illustrated by the programmes described below, which attempt to piece together narratives about such cases. The 'inclusivity profile' of particular technology deployments, for instance, needs to be understood through their life cycle of take-up and potential for diffusion. In their work on Participatory Impact Pathways Assessment, Alvarez et al. (2010, p. 956) underline that: 'The extent to which the good ideas and innovations

that [project participants] are generating influence, and are influenced by, other actors depends upon how people are linked to each other, the nature of those linkages, local norms, and power relationships.'

As a vital corollary to technology deployment, one key component in bringing sustainable energy to marginalised and poor communities in the Global South is correlating energy access with other vectors of poverty to compare relative capacities for impact in 'last mile' innovation. This revised way of considering impact deploying recognisable, measurable and comparable kinds of information depends on robust sets of categories with enduring value for use by a range of actors, public, private, third sector and regular citizens. Organising information about the impact in this way can allow for both greater research accountability and project implementation to reach out to targeted groups of beneficiaries, while also achieving effects of redistributive and procedural justice with regard to energy access outcomes.

Evolving priorities and policy drivers in the UK context

The UKAid Economic Development Strategy (DfID, 2017) is the clearest pronouncement by the UK government to date attributing a central role to energy provision in delivering inclusive growth in UK partner countries, through climate-smart approaches, innovative financing and working with other UK government departments as part of a coherent development strategy (DfID, 2017, Chapter 3). The strategy is intended to provide the basis for an evolving framework for UK energy policy support encompassing interlinked objectives of ensuring energy access for the poor, meeting the needs of energy for economic development and enhancing environmental sustainability, while also recognising that delivery should be context-aligned. This positive endorsement of the key importance of promoting transitions towards greener energy strategies among UK partners seems, however, to stand in sharp contradiction to other areas of UK international policy. For example, UK Export Finance continued provision of substantial funding for fossil fuel technology exports, which is being undertaken with little or no reference to this strategy and at a level far higher than that provided for renewable energy exports (see Makhijani, 2014).

Outside the political economy context of individual nation-state decision-making processes, global energy sector development continues to be driven strongly by the falling prices of renewables, increasing competitiveness and development of renewable energy markets, and the growing use of smart technologies, mobile-enabled payments, innovative financing and remote data monitoring. The interests of a range of different key stakeholders (public and private sector, donors and investors), and energy provision options involved in this rapidly evolving complex of interests, demand that more attention is paid to a whole-energy system approach to drive coherence, policy change and commercial viability to deliver the energy access goals.

DfID has expanded investment not only in energy programming, but also in energy research (see Figure 1). UK clean energy research for development has grown dramatically since 2010 (UKCDS, 2014), in part at least reflecting the development priority now placed on energy, the challenges and opportunities that achieving universal access to modern energy services presents, and the goals outlined above, not to mention the business possibilities for UK firms. What, though, have DfID's intentions been in terms of the perceived

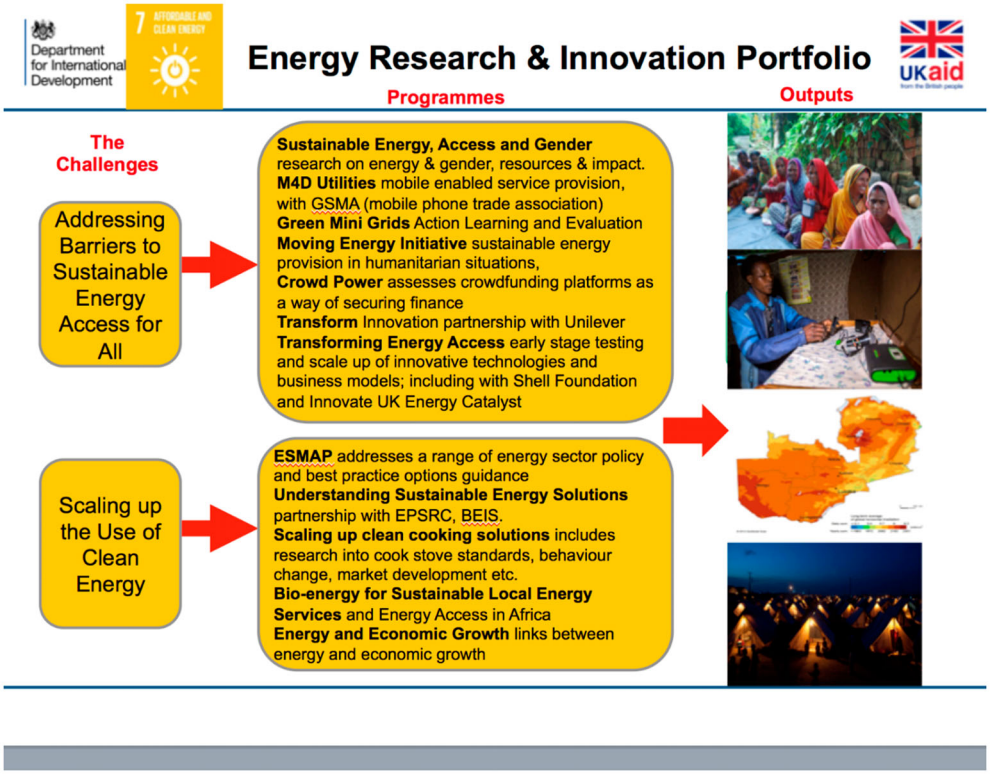

Figure 1. DfID energy research and innovation portfolio 2017.
Source: (supplied by Alistair Wray).

impacts of that research investment, the type of evidence that it is supposed to generate and the research partnerships supported, and what have been the actual effects?

A recent review of DfID (2016a) research considers the contribution that science and technology can make for development, the financial resources available in support of research and the importance of high impact research, innovation and strategic partnerships, but says little about the role of the social sciences. In part, this mirrors the UK HE and research community, which has only recently begun to map out and understand the indispensable role that collaboration between the social and natural sciences has in pushing forward the boundaries of low carbon energy transitions, and in rebalancing the prevalent voices in framing energy transitions discourse. DfID plans to continue to invest 3 per cent of the aid budget on research, judging value for money in terms of impact, additionality, quality, deliverability and cost, and it is the central role of the research and practitioner community in the UK to make the case for techno-social collaborations in this area. An evolving, multi-layered and inclusive understanding of impact is therefore key, requiring strong techno-social partnerships in priority research areas to optimise impact, and emphasising that outcomes should be judged on impact for priority stakeholders rather than purely on academic merits. It needs to be acknowledged furthermore that the projects referenced subsequently in this article are but one arc of an energy transitions wave.

Transforming and scaling up smarter energy access is an integral part of the DfID research agenda and climate and energy research and innovation are due to continue to receive significant investment. At the time of writing, the UK had committed to doubling renewable energy research, development and demonstration over 5 years by 2020/2021 under the Mission Innovation (2017) initiative and the UK Energy Innovation Programme. As part of an internal review of clean energy research and innovation needs, DfID (2014) identified five main drivers, which have helped shape the resulting portfolio after 2014:

- International development priorities in promoting sustainable energy for all;
- Growth in demand for energy, supply response scenarios and climate-resilient considerations;
- Emerging policy positions – fossil fuel subsidies, energy security, diversity of supply and energy efficiency;
- Raising awareness of renewable energy resources, their real costs and opportunities;
- Promoting technology innovation and the role of the private sector.

An informed policy analysis of the development challenges, review of research objectives and analysis of development potential has led to the emergence of three inter-linked research themes: addressing the barriers to sustainable energy access for all; scaling up the use of clean energy and providing energy for growth. An underlying theory of change within DfID's research investments links the proposed research activities and outputs to expected outcomes and their impacts. There remain, however, some questions over how those impacts (differently defined for different parts of DfID's research programme) might best be measured and progress evaluated. Some measurements draw on common generic research deliverables, each with reportable indicators, including: academic research publications aiming to improve understanding of energy options and opportunities; specific publications aiming to improve operational understanding and local context; proposals for improving local capacity and skills, including in the area of research; and proposals for improving access to knowledge.

Research programmes more focused on innovation may also include deliverables targeting technologies supported through the different stages of technology readiness, and business models that are tested and scaled up. Anticipated outcomes that capture the potential contribution to evidence-based policymaking include the cumulative number of enabling policy and environment examples informed by the research in target countries – energy regulations, legal measures, adopted reforms, policy guidelines, frameworks, tools, models – and relevant projects and proposals reflecting and incorporating research findings. Other DfID energy research programme developments include the commissioning of a number of increasingly large-scale programmes of energy research, which illustrate evolving thinking on the management and delivery of research, the contribution potential of different stakeholders and the processes of delivering research impact (for examples of such projects see https://www.lcedn.com/initiatives/category/USES-Network)

DfID's rapidly growing applied research programme in this area has been characterised by changes in terms of the researchers involved, greater local engagement and more demanding reporting requirements, reflecting the rapidly evolving nature of the sector

and funders' expectations. The programme is characterised by a broadening of the dimensions of research partnerships, a tighter definition of research scope, and integration of innovation and business support, different forms of commissioning of research, co-funding and a growing attention to research impact.

A key dimension to this evolution has been an increasing engagement with the academic community, in the UK and internationally, as well as with a range of Southern partners, civil society and philanthropic foundations, innovators and businesses, and investors. Concerns about climate and about growing green markets have led to exploring the best ways of supporting the take-up and adoption of promising technologies and business models, and creating conducive eco-systems in the UK and developing countries. The shift to a more applied focus to DfID-supported research and innovation work has brought in a wider range of research partners, including innovators and business incubators, facilitated by applying the theory of change approaches (Vogel, 2012). More attention has been paid to the importance of local energy contexts and social science perspectives, although a considerable need remains for further engagement with, and prioritisation of, the social sciences. The importance of broader and more longitudinal research activity remains. Collaborative partnerships with the relevant research councils, including through the Global Challenges Research Fund, could provide an important basis for combining energy-related applied research and more academic research as well as a basis for effective networking to deliver coherence and value for money, although the prospects for such collaboration at least in the energy sector currently remain unclear, and the spaces for qualitative social science analysis of contexts affecting low carbon transitions in the communities of the poor and marginal are few and far between as compared to technically driven research projects.

The network approach to measuring impact: the USES programme

Alongside the UK government's growing international involvement in tackling international energy poverty, recent years have seen a surge of interest in research on the imbricated themes of climate change, energy access issues and low carbon transitions among academic organisations. The LCEDN was launched by UK researchers in 2012 to respond to this interest and the demand for interaction and cooperation on research for low carbon development described above, bringing together the diverse and multi-disciplinary UK academic community working on energy and development issues and building relationships with business, public sector and civil society organisations in the same fields. Initially centred on five academic research centres, it has expanded to include practitioners, civil society, the private sector and the policy community. The network aims to pinpoint UK strengths, identify where they could best be deployed and highlight areas where expertise needs further development, specifically by identifying commonalities of interest and encouraging disparate stakeholders with little or no knowledge of each other's work and interested to learn each other's language as a first step to cooperation.

The Understanding Sustainable Energy Solutions (USES) research programme (jointly funded by EPSRC, DFID and DECC), which was initiated in 2013 has grown into a subsidiary network assemblage of the LCEDN, dedicated to providing a platform for deepening the work of the LCEDN and its interactions with DfID, increasingly through a growing body of international partners. The key research themes of the USES programme (https://

www.lcedn.com/initiatives/category/USES-Network) emerged out of conversations between funding bodies, brokered via their interactions at LCEDN management committee meetings, and discussions initiated with the wider research community at LCEDN events. The overall intention of the programme was:

> to increase clean energy access, resilience and wealth creation in developing countries (particularly for the urban and rural poor), through high quality research that improves the understanding and evidence-base of opportunities and challenges associated with clean energy for development. (EPSRC/DfID/DECC, 2012, p. 1)

The development of the programme was explicitly connected to the UK government's recognition of the growing urgency of tackling climate change and the need to contribute to a longer-term goal of increased clean energy access, resilience and wealth creation for low-income households in developing countries. The overall objectives of the programme, focusing on five themes – energy systems and decentralised use, solar, bioenergy, urban and transport, and energy efficiency – were that it would lead to: improved understanding of clean energy options and opportunities for developing countries; improved understanding of the social, market and political economy aspects of scaling sustainable energy access for poor people; strengthened developing country research capacity on clean energy and improved access to practical and policy-relevant knowledge on the challenges and opportunities for sustainable energy solutions in developing countries. The programme funded 13 projects, each of which involved research taking place in more than one country. Each project brought together researchers from a variety of different disciplinary backgrounds and involved collaborations beyond the academic community through partnerships with NGOs, policymakers and/or private sectors actors.

The programme provided an opportunity to develop a practical platform for encouraging dialogue between the UK academic community and DfID's research and evaluation division. Alongside the individual projects, the LCEDN provided a networking platform for the researchers to discuss experiences and explore synergies and cross-cutting themes. The LCEDN's original role in networking the projects for EPSRC was expanded via DfID funding to take on a greater technical monitoring and reporting role, promote the means and measurement of research outcomes and impact and provide opportunities for joint activities designed to engage with stakeholders and enhance the take-up of the lessons learnt across the programme as a whole.

The USES programme highlighted different expectations and approaches to research impact. Measurements of impact needed to capture the interest of the research councils in academic output and impact case studies, as well as the interest of DfID in developmental outcomes. However, initial reporting requirements tended to focus on relatively short-term impacts and did not reflect the wider understanding of networked impact outlined in this paper. These differential definitions and expectations of impact were themes that resurfaced fairly frequently during ongoing discussions of impact among the USES network partners, which provided a number of useful lessons on the dimensions and contours of research impact.

The relatively short-term nature of the projects, a common critique by researchers and practitioners, and the lack of channels for follow-up projects meant that potential impact through capacity building and network establishment frequently could not be fully

realised. One USES project observed a major shift in perspective among policy actors, but identified as a major risk that 'once funding ceases, stakeholders go back to their routine'. Others pointed out that the need to devote funding to engagement and policy uptake activities had too often been underplayed in project formulation and implementation and had required additional expenditure. Some trade-offs were also identified between different measures of impact required by different funders. For example, one USES project reported that:

> some of the journal papers have been published in less prestigious journals than the administrative PI would normally aim for but it is hoped that these will be of more relevance to Southern partners, and they have to date generated significant implementation interest from a variety of stakeholders. (personal communication)

The USES projects produced a diverse range of outputs including academic journal articles (both top-rated internationally leading journals and the more practically focused, frequently regional, journals mentioned in the comments above), books, book chapters, policy briefs, apps, economic models, data sets, toolkits, decision support tools and videos. Greater training and support for researchers would enhance the production of non-academic outputs and other forms of media to engage other sectors and to disseminate the outcomes of the research more widely. USES network meetings provided opportunities for cross-fertilisation of successful impact strategies but the need was identified for better capture and communication of collective achievements and results against anticipated outcomes and impact indicators.

The experiences of the USES projects showed that the dialogical production of impact depends heavily upon time, resources and wide stakeholder involvement. It takes time to build relationships and platforms, to share knowledge and develop impact, and it is these relational conditions of possibility for an impact that need much better recognition in participatory ownership of project objectives. Research does not automatically lead to impact, so considerable resources need to be devoted to creating opportunities, nurturing relationships and influencing policy strategically. The diversity of voices requires the identification of stakeholders and facilitation of cross-sectoral understandings. For example, one USES project reported:

> The … field is complex and highly political. Relationship building is therefore important but also a slow process. One realisation … is the need to be opportunistic in developing win-win partnerships.

Using these learnings, and drawing on the support of the LCEDN, DfID has developed a series of platforms where the uptake of learning from the UK research programme can be better coordinated and lessons shared. This has now been taken forward more systematically in the new Transforming Energy Access (TEA) programme. The TEA programme provides an example of how different partners and approaches are being integrated into a multi-layered programme aiming to increase the use of affordable decentralised clean energy options for poor households and enterprises, through a combination of innovative technologies, delivery models and financing, and complementary capacity building, providing for a particular focus on research uptake and impact measurement. Like USES, TEA is intended to embrace a wide range of stakeholders including researchers from a variety of disciplines, innovators and entrepreneurs, social impact investors, utility and public

sector employees, and evaluators often with differing perspectives and ways of working. The overall TEA programme objective is

> [to] deliver new technologies and robust evidence on the critical barriers hampering systemic change and scaling up energy access, working with Southern researchers and entrepreneurs to drive locally relevant innovation and delivery. (DfID, 2016b, p. 2)

Taken as a whole, TEA is expected to have a transformative impact on the design and deployment of renewable energy solutions across the Global South, especially in Africa. The LCEDN's programme of support builds on the experiences of the USES programme and focuses on capacity building around a number of key themes essential for achieving the goals of the TEA, namely: gender, governance, value chains, innovative forms of finance and delivery models, waste and sustainability, approaches towards innovation, impact assessment methodologies, and transdisciplinary and cross-sectoral working. The intention is to help integrate and strengthen the wider UK energy and development research and innovation delivery context, including working with other major initiatives such as DfID's Energy and Economic Growth programme, the EU Africa Energy Partnership and other initiatives.

Conclusion

This paper has explored briefly the different ways in which impact is conceived by the diverse set of actors involved in research and innovation around low carbon energy and international development in the UK, and the ways in which conversations on impact are being undertaken to improve the value of the term to funders, as well as measuring real change in beneficiary communities. The experience of DfID's USES Programme has shown that measuring and improving impact in relation to energy trilemma initiatives requires careful re-consideration and review of these diverse needs. The programme also demonstrated the need to recognise and devote specific resources to achieving longer-term actor–network dialogues and capacity-building impacts beyond individual projects, and using these to build a more networked approach to strengthening impact. These are issues that need to be taken into account when judging the impact of interventions funded under the RCUK's GCRF programme, and that require social science intelligence to temper lingering technology transfer models of how development happens.

It is interesting to observe that TEA also contains a component designed to explore opportunities to take forward follow-up learnings from the USES programme and others designed to nurture relationships and knowledge sharing at a regional level. For example, the TEA programme start-up phase includes a set of coordinated actions in East Africa, with actions focused on trailing innovative ways to disseminate academic outputs with targeted support, contributing to workshops exploring the role of governance with policymakers in the region as well as a final workshop focused on the USES projects working with local communities. The USES network hosted several discussions around different conceptualisations of impact that have fed into the design of a workstream under the TEA initiative revolving around detailed assessments of the existing relationships between researchers, policymakers and other stakeholders within specific national contexts (initially Kenya and Bangladesh), the assessment of knowledge needs

and identification of communication channels and development of joint impact planning activities across different sectors.

The evolution of a whole system approach to low carbon energy provision and integrated energy research programmes such as the TEA highlight the potential to build such networks. As the UK energy research programmes develop, and increased attention is paid to strategic partnerships and research impact, the kind of networking and outreach promoted by the LCEDN over the past five years can be seen increasingly as an important means of bringing different communities and interests together, and building relationships between UK policymakers, academia, entrepreneurs and business (while acknowledging their mutual frictions). It is only through the establishment of these long-term relationships and coordinated programmes that the wider less linear and more emergent versions of impact and innovation for SDGs can be nurtured and developed in response to the articulated perceptions of energy needs of poor and marginalised women and men (Ely, Smith, Leach, Stirling, & Scoones, 2013). These insights have been incorporated into the initial fast-track activities for the TEA programme, but further work is needed on refining research impact measurements, which go beyond reporting and help build collaboration.

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